PATENT COOPERATION TREATY

REC'D 04 MAR 2005

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 1682H/MG	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IT 03/00843	International filing date *(day/month/year)* 19.12.2003	Priority date *(day/month/year)* 19.12.2002
International Patent Classification (IPC) or both national classification and IPC B41J2/14		
Applicant OLIVETTI I-JET S.P.A. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
15.07.2004	02.03.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Bridge, S Telephone No. +49 89 2399-2837

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IT 03/00843

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-3, 5, 7-9	as originally filed
4, 6	received on 14.01.2005 with letter of 10.01.2005

Claims, Numbers

1-10	received on 14.01.2005 with letter of 10.01.2005

Drawings, Sheets

1/5-4/5	as originally filed
5/5	received on 14.01.2005 with letter of 10.01.2005

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-10
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-10
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-10
	No:	Claims	

2. Citations and explanations

   see separate sheet

V Statement according to Article 35(2) PCT – Novelty, inventive step & industrial applicability

Closest prior art : D1 = US-A-6 423 241 discloses a process for protectively coating an ejection chamber (504) of an ink jet printhead, to reduce damaging effects of aggressive inks, comprising the following steps:

step a): disposing of a die comprising a silicon substrate (501) covered by a plurality of metallic and dielectric layers (506,505,601) in which is made an array of microcircuits for driving of thermal elements (506) for ejection of said ink, and also comprising a sacrificial layer (701,702,703), provided with a cast (703) for at least one ejection nozzle (507), said sacrificial layer (701,702,703) and said cast (703) defining the inner shape of a chamber (504), of a feeding duct (503) connected to it and of said at least one nozzle (507);

step d): depositing a structural layer (704) so as to completely cover said sacrificial layer (701,702)

step f): removing said sacrificial layer (701,702) and said cast (703) by means of a chemical etching.

A protective coating ("anti-corrosion plating") is applied after step (f), ie after the sacrificial layer has been removed to form the ink chamber(s).

Solution : According to "hydraulic microcircuits" method claim 9 and corresponding ink jet chamber method claim 1 :

step a): add a metallic sacrificial layer defining as a solid what will become the hollow hydraulic (ink) passages and chambers to an electric circuit carrying silicon substrate

step b): add a protective coating on the sacrificial layer

step c): add an adhesion layer on the protective coating

step d): add a resin "structural" layer (ie the walls enclosing the future ink channels and chambers)

step e): polymerize the structural layer;

step f:) remove the sacrificial layer with an acid bath (and thereby form the hollow hydraulic passages and chambers),

Effect : the resulting hydraulic microcircuit / printhead has improved resistance to corrosive liquids.

Objective problem : improve resistance to corrosive liquids.

Such a solution is neither disclosed nor suggested in any of the available prior art.

Therefore, the subject matter of the independent claims satisfies the criteria set forth in Articles 33(2)-33(4) PCT.

The dependent claims 2-8, 10 concern further technical details of the invention and are carried by the inventive idea of the independent claims. Therefore, the dependent claims also satisfy the criteria set forth in Articles 33(2)-33(4) PCT.

As anticipated, this description refers to a process relating to an ink jet printhead for treating the inner walls of the chambers, feeding ducts and nozzles of said head, in such a way as to offer high resistance against the aggressive agents of the inks employed; it is clear that the process mainly, though not exclusively, concerns the final part of manufacture of the head.

In the description that follows, therefore, the initial steps of manufacture of the printhead will not be described in detail, as these belong to the state of the art, well-known to those acquainted with the sector art, but the process of manufacturing the chambers, relative feeding ducts and injection nozzles, according to the invention, may be considered as applying to a conventional ink jet printhead, made in a first step in a way known in the state of the art.

Depicted in figure 1 by way of an example is a wafer 10 of crystalline silicon, on which die 12 are indicated, constituting a like number of conventional type ink jet printheads, not yet separated; the figure represents one of the die, in enlarged view, in which two zones 13 are indicated in which the driving microcircuits are arranged and the zone 14 enclosing the nozzles 15.

In figure ~~2~~ 3, represented by way of non-restrictive example is the section of a conventional ink jet printhead, in the state it is in after a first manufacturing phase, known in itself, in which the manufacturing process has come to the deposition of a sacrificial layer of copper in the zone where the chambers, relative feeding ducts and nozzles will be made; in particular, fig. ~~2~~ 3 shows this printhead, in which a die 20 can be seen which is made up of a substrate of silicon 21 covered by a plurality of metallic and dielectric layers, in which an array of microcircuits has been made for driving thermal elements 22, or resistors, for

At the end of this operation, chambers, feeding channels and nozzles are obtained with inner walls completely coated by the layer of noble metals, and therefore effectively protected from the aggressive action of the inks employed.

Naturally the inner shape of the chambers, feeding ducts and nozzles represents the true impression of the sacrificial layer, because the upper surface of the chambers and the ducts connected to them faithfully reproduce the outer surface of the sacrificial layer.

In particular, where the ink jet printhead used is that described in the Italian patent application entitled "~~Optimized~~ Ink jet printhead and relative manufacturing process", corresponding to the International patent application WO 2004/056574 A1, filed by the same applicant, and the manufacturing process that this invention refers to is applied, concave-shaped upper inner walls of the chambers and of the feeding ducts connected to them would be obtained, a faithful copy of the corresponding shape of the sacrificial layer made using the process described in the already cited ~~Italian~~ International patent application.

In the latter case, the twin advantage would be obtained of great resistance of the chambers and feeding ducts to the aggressive agents in the inks and a more effective prevention of air bubbles becoming attached to particular points of the walls, with optimization of the phase in which the expulsion bubble is developed.

Accordingly the process for producing chambers, relative feeding ducts and protected nozzles, according to this invention, continues starting from the state of progress of manufacture of a printhead, by way of non-restrictive example, of the type described in the cited ~~Italian~~ international patent application WO 2004/056574 A1, shown in fig. ~~2~~ 3, and proceeds in the steps described in the flow diagram of fig. 4, integrated with the explanatory drawings in figures 5 to 8.

CLAIMS

1. Process for protectively coating an ejection chamber (35) of an ink jet printhead, to reduce damaging effects of aggressive inks, comprising the following steps:

step a): disposing of a die (20) comprising a silicon substrate (21) covered by a plurality of metallic and dielectric layers (23, 24, 25) in which is made an array of microcircuits for driving of thermal elements (22) for ejection of said ink, and also comprising a sacrificial metallic layer (26), provided with a cast (27) for at least one ejection nozzle (37), said sacrificial layer (26) and said cast (27) defining the inner shape of a chamber (35), of a feeding duct (36) connected to it and of said at least one nozzle (37);

step b): depositing on the outer surface of said sacrificial layer (26), through an electrochemical process, at least one metallic, protective coating layer (30);

step c): applying on said coating layer (30) a layer, the adhesion layer, (31) having a thickness preferably of about 1000 A°, to promote the adhesion of resins on said protective metals (30);

step d): depositing on said adhesion layer (31) a structural layer (32) of non-photosensitive epoxy or polyamide resin, having a thickness preferably between 20 and 60 μm, so as to completely cover said sacrificial layer (26), including the cast (27) of the nozzle (37);

step e): performing a polymerization of said structural layer (32) to increase its mechanical resistance to mechanical and thermal stresses;

step f): performing a planarization of the outer surface (33) of said structural layer (32), by way of a mechanical lapping and simultaneous CMP type chemical treatment (Chemical-Mechanical-Polishing), or other similar process, to uncover the upper cap (34) of

the cast (27) of copper;

step g): removing said sacrificial layer (26) and said cast (27) by means of a chemical etching, using a highly acid bath, formed for instance of a mix of HCl and HNO3 in a solution;

step h): depositing on the outer surface (33) of said structural layer (32), in a vacuum evaporation operation, a protective layer (39) of thickness preferably of approximately 1000 A°.

2. Process according to claim 1, wherein said metallic coating layer (30) is made of nickel-gold;

3. Process according to claim 1, wherein said metallic coating layer (30) is made of palladium-gold.

4. Process according to claim 1, wherein said metallic coating layer (30) is made of rutenium.

5. Process according to claim 1, wherein said protective layer (39) is made of a noble metal.

6. Process according to claim 5, wherein said protective layer (39) is made of chromium.

7. Process according to claim 8, wherein said protective layer (39) is made of magnesium fluoride and oxygen ($MgF_2 + O_2$).

8. Process according to claim 1, wherein said protective layer (39) is made of silica and chromium ($SiO_2 + Cr$).

9. Process of protectively coating against aggressive liquids hydraulic microcircuits (35, 36, 37) made in a resin (32), comprising the following steps:

step a): disposing of a die (20) comprising a silicon substrate (21) covered by a plurality of metallic and dielectric layers (23, 24, 25), and also comprising a sacrificial metallic layer (26) defining the inner shape of said hydraulic microcircuits (35, 36, 37);

step b): depositing on the outer surface of said sacrificial layer (26), in an electrochemical process, at least one metallic, protective coating layer (30);

step c): applying on said coating layer (30) a layer, the adhesion layer, (31) having a thickness preferably of approximately 1000 A°, to promote the adhesion of resins on said protective metals (30);

step d): depositing on said adhesion layer (31) a non-photosensitive epoxy or polyamide resin (32), having a predetermined thickness and completely covering said sacrificial layer (26);

step e): performing a polymerization of said resin (32) to increase its mechanical resistance to mechanical and thermal stresses;

step f): removing said sacrificial layer (26) via a chemical etching, by means of a highly acid bath, formed for instance of a mix of HCl and HNO3 in a solution.

10. Process according to claim 9, further comprising the following steps :

step g): performing, after step (e), a planarization of the outer surface (33) of said resin (32), through a mechanical lapping and simultaneous CMP type chemical treatment (Chemical-Mechanical-Polishing), or other similar process; and

step h): depositing, after step g), on the outer surface (33) of said resin (32), in a vacuum evaporation operation, a protective layer (39).

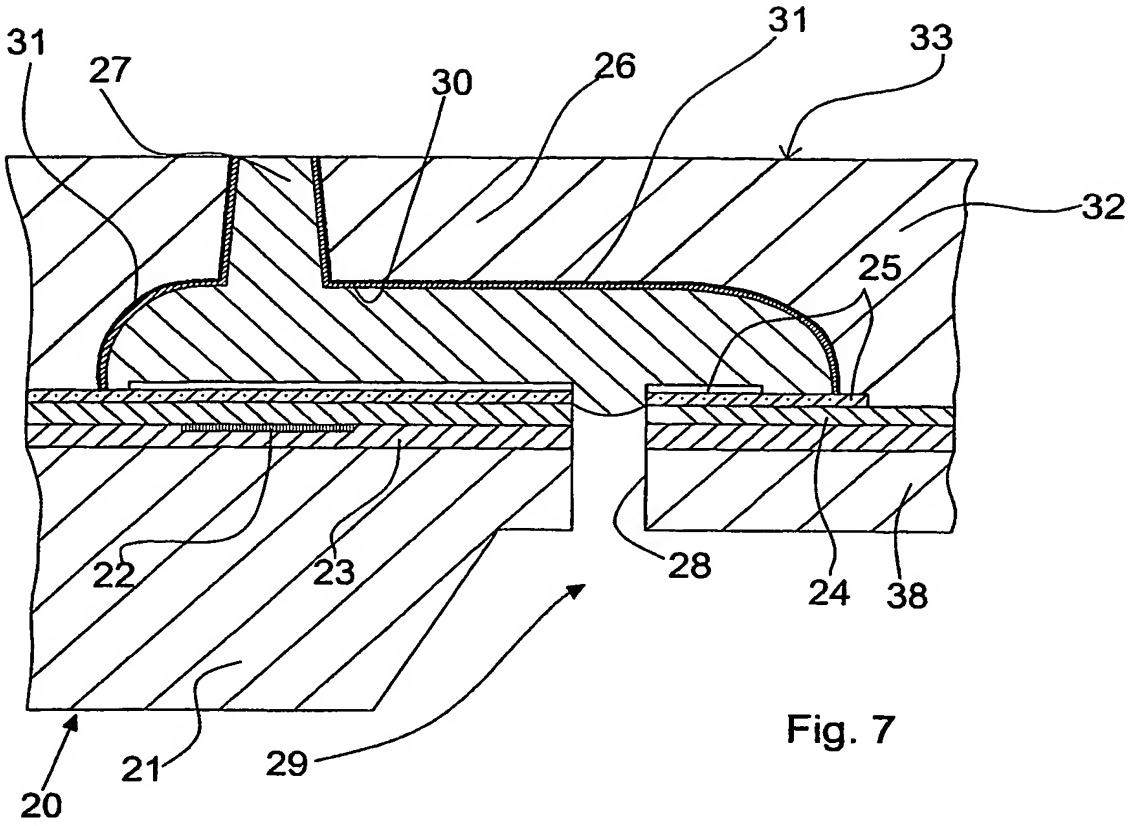
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Fig. 7

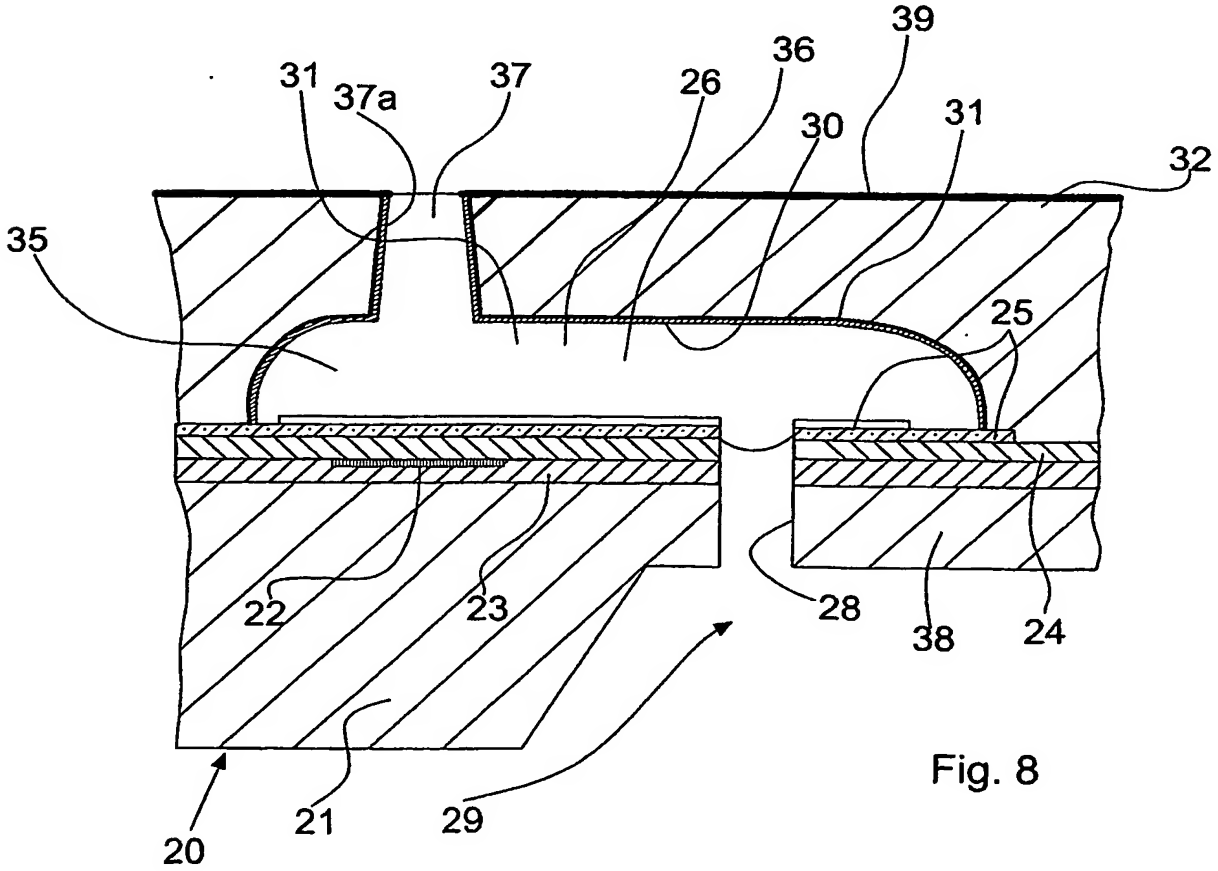
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Fig. 8